OIL THREAT TO AQUATIC BIRDS ALONG THE YUKON COAST

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Major oil exploratory activities are planned for the Beaufort Sea (Petroleum and Natural Gas Department 1973). Permission already has been granted to AMOCO Canada, a designated operator for a group of oil companies, including Gulf Canada, Hudson's Bay Oil and Gas, and Mobil Oil, to drill an exploratory well on Herschel Island in 1976. Herschel, a former whaling and Royal Canadian Mounted Police station situated on the east coast of Herschel Island, may develop into the major oil exploration and shipping port in the Canadian Sector of the Beaufort Sea (Barry 1970). Since the oil exploration activities may pose a threat to the aquatic birds in the area, we conducted surveys along the Yukon coast for further information on late summer and fall concentrations of birds at sea.

METHODS AND DESCRIPTION OF THE AREA

From 1 August to 21 September, 1973 we conducted a survey of bird occurrence on the beaches and coastal waters of the Yukon Territory (Fig. 1). The survey was divided into 2 phases. Aerial surveys of the entire coastline were flown at intervals and ground observations were made at Herschel Island, where a camp was maintained from 1 August to 8 September. Weather was a limiting factor in this study. Fog occurred frequently and often so unexpectedly that on several occasions an aerial survey had to be discontinued. The fog was often so dense that even ground observations could not be carried out. Surveys were flown in a Cessna 185 float plane from Inuvik, Northwest Territories, during various times of the day depending on visibility and availability of aircraft. An average height of 60 m and air speeds varying from 110 to 190 km per hour were used, depending on visibility and number of birds encountered. A single transect approximately 0.2 km from the coast was flown to count the birds within approximately a 0.4 km wide transect along the coast. Where additional features such as islands and bays were encountered as many additional circuits as needed to cover the enclosed waters and shores were made. One observer was present making observations assisted by the pilot who pointed out flocks of birds.

Ground observations of aquatic birds were made from the base of Avadlek Spit to 1.6 km east of Lopez Point along the south shore of Herschel Island (Fig. 1). Counts were made between 22:00 and 23:00 because then the majority of birds were roosting on the beaches, having returned from between Herschel Island and the mainland. When the water was glassy-calm, birds could be counted over three-quarters of the bay area from a vantage point on a hill on the south side of the island using a 20 × spotting scope. This method combined with aerial surveys of the birds between Herschel Island and the mainland also provided an estimate of the total number of birds present.

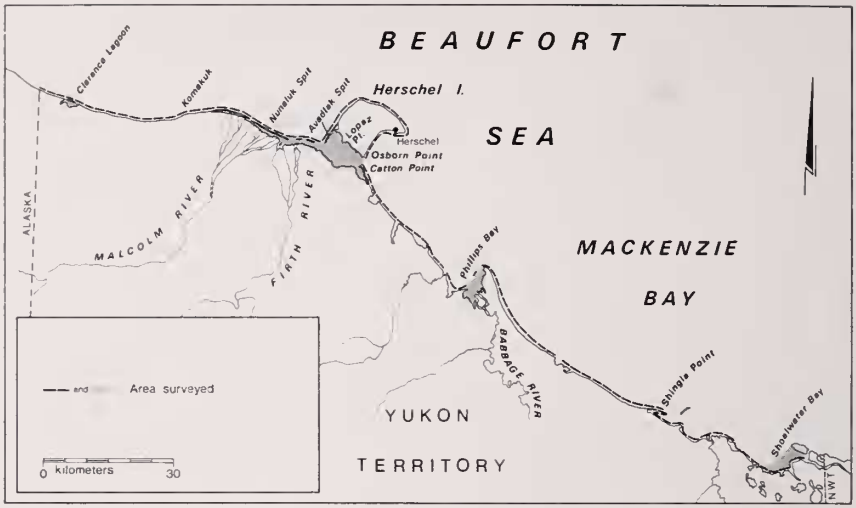

FIG. 1. Yukon coast showing 1973 aerial survey routes.

Some data on bird migration were also obtained during aerial surveys and by watching from various vantage points on Herschel Island.

Much of the Yukon coast is rather barren, with low bluffs abruptly dropping down to a narrow gravel beach. All but the south shore of Herschel Island (size: 115 km^2; highest altitude: 180 m) is of this type of habitat except that the bluffs tend to be higher and the gravel beach is non-existent. The mud bluffs drop directly into the sea.

Where rivers flow into the ocean bays, mud bars and sandspits are often present. This is the case with the Blow River where it enters Shoalwater Bay on the western end of the Mackenzie Delta, with the Babbage River at Phillips Bay, with the Firth and Malcolm rivers at the coast south of Herschel Island, and with several smaller rivers entering Clarence Lagoon. These places are favored by migrating brant (*Branta bernicla* or *B. nigricans*) and smaller numbers of other species such as Glaucous Gulls (*Larus hyperboreus*), phalaropes (mostly *Lobipes*), scaup (*Aythya* sp.), and Red-breasted Mergansers (*Mergus serrator*). Whistling Swans (*Olor columbianus*) and Pintails (*Anas acuta*) frequently occur on freshwater ponds near the shoreline and occasionally on the brackish and salt waters nearby.

With the exception of a few ice floes, the sea east of Herschel Island was ice free as far as we could see from a plane. Wind direction determined the amount of ice present west of Herschel Island. After a day or two of southerly winds, the ice would retreat almost out of sight, but would move in again with a northerly wind. The area from west of Komakuk was generally filled with ice. Nowhere was a solid ice cover encountered.

RESULTS

The total number of aquatic birds observed along the Yukon coast during August and September 1973 is shown in Table 1. The sea ducks,

Table 1

Number of Aquatic Birds Observed Along the Yukon Coast, August–September 1973

Species observed	Date of aerial survey					
	August 9, 12	August* 23, 24	August 31, Sept. 1	Sept. 10	Sept. 14	Sept. 21
Ducks						
Oldsquaw	1617	2181	1464	672	978	1910
Surf Scoter	2617	1458	618	353	579	158
Scaup**	140	175	163	77	93	161
Eider sp.***	78	5	226	18	54	221
Red-breasted Merganser	6	0	5	14	58	139
Pintail	26	55	48	6	0	0
American Wigeon (*Anas americana*)	0	7	0	0	0	0
Unidentified ducks	15	0	45	21	8	31
Shorebirds						
Northern Phalarope	2600	300	100	0	30	0
Unidentified shorebirds	65	500	100	10	0	0
Geese						
Brant sp.	125	541	1746	202	22	30
Snow Goose	0	90	260	0	0	24
White-fronted Goose (*Anser albifrons*)	0	47	0	4	0	137
Canada Goose (*Branta canadensis*)	0	0	6	0	0	0
Gulls and Terns						
Glaucous Gull	281	293	475	281	222	401
Arctic Tern	116	28	0	0	0	0
Swans						
Whistling Swan	49	25	29	40	7	19
Loons						
Red-throated Loon	60	14	51	5	4	0
Arctic Loon (*Gavia arctica*)	6	4	3	0	12	4
Common Loon (*Gavia immer*)	2	1	6	1	0	0
Yellow-billed Loon (*Gavia adamsii*)	1	0	0	1	0	0
Small unidentified loons	0	0	0	0	0	3
Jaegers						
Parasitic Jaeger (*Stercorarius parasiticus*)	4	9	1	0	0	0
Long-tailed Jaeger (*Stercorarius longicaudus*)	2	0	0	0	0	0
Cranes						
Sandhill Crane (*Grus canadensis*)	3	2	7	0	0	0

* The area from Osborn Point to the Alaska border was not surveyed at this time.
** Mostly Greater Scaup.
*** Mostly female Common Eiders.

Table 2

Ground Counts of Oldsquaws and Surf Scoters Along the South Side of Herschel Island, August–September, 1973

Date of observation	Number observed	
	Oldsquaws	Surf Scoters
August 2	1285	1500
August 5	1550	3205
August 13	2133	1835
August 15	1901	1640
August 20	2450	740
August 27	749	253
August 28	487	209
August 29	560	9
September 2	190	0
September 4	150	6

such as Oldsquaws (*Clangula hyemalis*), Surf Scoters (*Melanitta perspicillata*), scaup and eiders, presumably mostly Greater Scaup (*Aythya marila*) and Common Eiders (*Somateria mollissima*), were the most numerous seabirds encountered. Large numbers of molting Oldsquaws and Surf Scoters were observed along the shore and in the water south of Herschel Island during the first 3 and 2 weeks of August respectively (Table 2). From ground observations at Herschel Island and aerial surveys of the birds between Herschel Island and the mainland, we estimated that 5500 Oldsquaws and 4500 Surf Scoters concentrated along the south side of Herschel Island during the molt. No such concentrations of sea ducks were noted anywhere else along the Yukon coast. Small numbers of Common Goldeneyes (*Bucephala clangula*), Harlequin Ducks (*Histrionicus histrionicus*), scaup, Common Eiders, and Red-breasted Mergansers were observed with the Oldsquaws and Surf Scoters. Oldsquaws used a wide range of habitat. Small groups were observed far out at sea but the greatest number was found along the beaches and bays. Oldsquaws occurred in the bay near the base of Avadlek Spit, inside the reef barriers off the Firth-Malcolm Delta and inside Catton Point. Surf Scoters were found in concentrations only south of Herschel Island. Surf Scoters started to depart from the waters south of Herschel Island and the Yukon coast as a whole during the latter half of August (Tables 1 and 2) while aerial surveys showed that Oldsquaw numbers did not decline along the Yukon coast during September (Table 1).

We observed small flocks of molting scaup along the coast but found

no concentrations. The maximum number recorded was 175 on the 23, 24 August aerial survey. Numbers fluctuated little throughout the study period, although flocks that had been noted on successive surveys in the same location during August moved, presumably as part of the fall migration. Although fewer than 60 scaup were observed on occasion with the molting birds concentrated along the south side of Herschel Island, more were usually found in sheltered bays along the coast.

Flocks of female eiders were occasionally encountered along the coast during aerial surveys but we observed no concentration or flights. No males were seen. The large numbers that pass through this area (Barry 1968, 1970; Snyder 1957; Thompson and Person 1963) do so farther out at sea. An estimated 35 pairs of Common Eiders nested on the first barrier reef island east of Nunaluk Spit in 1972 (M. A. Gollop, pers. comm.). Kees Vermeer checked the location on 18 July 1973 but found no nests. Six broods of Common Eiders were seen near Avadlek and Nunaluk Spits in 1973.

Large numbers of shorebirds pass chiefly along the mainland coastline (M. A. Gollop, pers. comm.). Only Northern Phalaropes (*Lobipes lobatus*) stopped in their westward migration in large numbers along the south shore of Herschel Island (Fig. 2). Phalaropes fed along the beaches, in the lee of ice floes and on the open waters of the ocean. They preferred sheltered waters such as lagoons on windy days. The build-up of phalaropes at Herschel Island was of short duration (Fig. 2). We believe many more thousands of phalaropes migrated through the area than we saw. About 2.5% of the phalaropes seen were Red Phalaropes (*Phalaropus fulicarius*), the remainder were Northern Phalaropes. Besides phalaropes, thousands of Pectoral Sandpipers (*Calidris melanotos*) were seen moving eastward along the mainland coast at Nunaluk Spit on 9 and 10 August. Thousands of Golden Plovers (*Pluvialis dominica*) were also observed migrating eastward over Avadlek Spit on Herschel Island from 20 to 25 August. An estimated 600 plovers stopped to roost on Avadlek Spit on 20 August. Thousands of Golden Plovers were observed flying eastward over the Yukon North Slope during the latter part of August (M. A. Gollop, pers. comm.) suggesting that the majority of plovers do not pass over Herschel Island. We saw small numbers of Ruddy Turnstones (*Arenaria interpres*), Semipalmated Sandpipers (*Calidris pusilla*), Least Sandpipers (*Calidris minutilla*), Sanderlings (*Calidris alba*), and Long-billed Dowitchers (*Limnodromus scolopaceus*) on or flying over the beaches of southern Herschel Island.

Brant were the geese most frequently seen. They concentrated in the coastal lagoons, on river deltas, and in bays along the coast during migra-

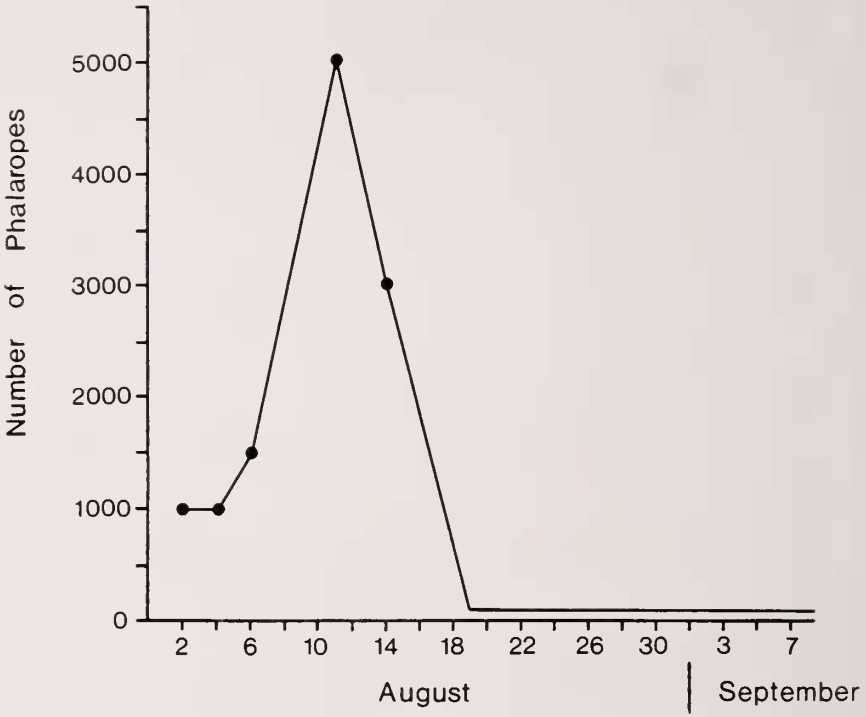

FIG. 2. Ground counts of phalaropes during autumn migration along the south shore of Herschel Island.

tion. The shores and flats of Shoalwater Bay and Phillips Bay, Clarence Lagoon, and especially the area between Nunaluk Spit and the Firth-Malcolm River Delta are used by brant during this time. Brant were observed migrating westward along the mainland from the south side of Herschel Island on 24 (60 birds), 25 (23), and 29 August (45), and on 3 (5 flocks, 235 birds) and 5 September (3 flocks, 160 birds). Most Brant had left the Yukon coast by the third week of September (Table 1).

Hundreds of thousands of Snow Geese (*Chen caerulescens*) use the Yukon North Slope in September (T. W. Barry, pers. comm.) but they generally do not use the marine waters. Snow Geese move mainly along the Yukon North Slope, and rest and feed on the tundra. The only Snow Geese noted on salt water were 90 birds observed on the Firth-Malcolm River Delta on 26 August. Other birds recorded on aerial surveys were birds in flight moving along the coast. The incoming movement of Snow Geese does not appear to follow a well-defined path. Birds appear from

TABLE 3

COMPARISON OF NUMBERS OF AQUATIC BIRDS OBSERVED AT SEA 0.2 KM AND 1.6 KM FROM THE SHORELINE FROM OSBORN PT., NORTH AROUND HERSCHEL ISLAND, TO THE ALASKA BORDER, 1 SEPTEMBER, 1973

Species	Distance at sea from shoreline	
	0.2 km	1.6 km
Red-throated Loon	9	2
Whistling Swan	5	0
Brant sp.	380	0
Canada Goose	4	0
Scaup sp.	15	0
Oldsquaw	386	65
Surf Scoter	300	0
Eider sp.	50	2
Unidentified ducks	30	0
Parasitic Jaeger	1	0
Glaucous Gull	25	5
Total number observed	1105	74

out over the ocean and move southwest onto the Slope. The return migration east to the Mackenzie Delta is mainly over the Slope but in some years the Snow Geese fly back to the Delta over the sea (T. W. Barry, pers. comm.).

Glaucous Gulls, the only gull species noted, were dispersed along the entire Yukon coast. Most gulls were observed near colonies on islands south and southwest of Avadlek Spit, at Phillips Bay, near Shingle Point, and at the settlement of Herschel where offal attracts them. We estimated from aerial observations on 18 July 1973 that approximately 150 pairs were breeding along the Yukon coast. Arctic Terns (*Sterna paradisaea*) also were dispersed along the coast, especially from Herschel Island eastward. The terns departed by the end of August (Table 1). Arctic Terns nested on the island off the tip of Nunaluk Spit in 1972 (M. A. Gollop, pers. comm.).

Whistling Swans were observed on small freshwater ponds along the Yukon coast, especially around Shoalwater and Phillips bays (Table 1). We observed only a few family groups or pairs on brackish or salt water. Their migration followed the coastline but was over land. Although we saw occasional flocks of swans over the sea, we noted none on salt water.

The Red-throated Loon (*Gavia stellata*) was the loon species most frequently observed. Although no visual migration of Red-throated Loons

was observed. their departure from the area is evident from the aerial surveys (Table 1).

On 1 September. while returning from the Alaska border, birds were counted within a .4 km wide transect 1.6 km from land. Only a small fraction of birds was encountered there compared to the numbers seen closer to the coast (Table 3). Frame (1973) reported sighting only 1834 birds over a 550 km cruise in an icebreaker, approximately ranging 50 to 190 km out at sea north of Alaska and the Yukon from 3 to 15 August 1969. The number of 10-min observation periods for 16–64, 65–112, 113–160, and 161–208 km zones from the nearest land were 53, 37, 25, and 37 respectively. The mean number of birds seen per observation period within these zones was 22. 10. 10. and 1 respectively. Bartels (1972) who conducted aerial and boat surveys of sea ducks out to 104 km from the Alaskan north coast during August and September 1971, observed no ducks beyond 56 km. He also reported that 84% of the observed Oldsquaws, the most numerous ducks present, were within 8 km of the shore. From Frame's, Bartels', and our observations it appears that most aquatic birds in the Beaufort Sea are found in the vicinity of the coast during late summer.

DISCUSSION

The Oldsquaws and Surf Scoters appear to be most vulnerable along the Yukon coast to oil pollution because of their molting in concentrations in the barrier-reef protected waters south of Herschel Island. Oldsquaws, scoters and other sea ducks are among the most frequent bird victims of oil pollution in the world's seas (Table 4) because of their presence in heavily navigated sealanes. their large numbers. time spent on the water. and their behavior toward oil slicks. Oldsquaws and scoters dive for food so that when they emerge, they become covered with oil. Oldsquaws sometimes land on oil patches where the deep sea rolls are less heavy (Curry-Lindahl 1960). More than 100.000 Oldsquaws were reported killed by oil discharges from 1952 to 1962 in the Baltic Sea alone (Lemmetyinen 1966). As a consequence of the recurring heavy mortality from oil pollution in the Baltic, the number of Oldsquaws migrating through Finland had been reduced by 1960 to 1/10 the number recorded in the late 1930's (Bergman 1961). Scoters have also been hit hard by oil spills. Goethe (1968) estimated that 500.000 birds. predominantly Black Scoters (*Melanitta nigra*) were killed by the grounding of tanker. *Gerda Maersk*. in northwest Germany. Lemmetyinen (1966) and Joensen (1972) reported approximately 50.000 scoters killed in Baltic and Danish waters from 1962 to 1972 from oil discharges other than from tanker accidents.

Besides sea ducks. alcids are among the most frequent bird victims

TABLE 4

BIRD MORTALITIES RESULTING FROM OIL TANKER ACCIDENTS AND FROM OIL DISCHARGES OTHER THAN TANKER ACCIDENTS IN THE WORLD'S OCEANS AND SEAS

Type of victims	Number of instances reported as predominant victims	Source
Sea ducks (e.g. Oldsquaws, eiders, scoters)	24	Brown et al. (2 instances) 1973, Burnett and Snyder 1954, Goethe 1968, Horwood 1959, Joensen (5 instances) 1972, Lemmetyinen (6 instances) 1966, Marine Pollution Bulletin 1970 1:117, Richardson 1956, Smail et al. 1972, Soikkeli and Virtanen 1972, Swennen and Spaans 1970, Tanis and Mörzer Bruyns (2 instances) 1968, Technical Advisory Committee for oil pollution on the Tay 1968.
Alcids (e.g. murres, razorbills)	12	Aldrich 1938, and Moffitt and Orr 1938, Bourne et al. 1967, Brown et al. (2 instances) 1973, Hope-Jones et al. 1970, Marine Pollution Bulletin 1970 1:117, Richardson 1956, Smail et al. 1972, Tanis and Mörzer Bruyns (2 instances) 1968, Tuck 1960, Wright 1971, Smithsonian Institution Center for Short-lived Phenomena 1971, Card no. 1234–1235.
Diving ducks (e.g. scaups, mergansers)	3	Ranwell and Hewett 1964, Smithsonian Institution Center for Short-lived Phenomena 1970, Card no. 873–874, Vereshchagin 1946.
Shorebirds	2	Harrison and Buck 1967, Ranwell and Hewett 1964.
Grebes	2	Ranwell and Hewett 1964, Smail et al. 1972.
Penguins	2	Westphal and Rowan 1970.

TABLE 4—*Continued*

Type of victims	Number of instances reported as predominant victims	Source
Loons	1	Smithsonian Institution Center for Short-lived Phenomena 1970, Card no. 873 and 874.
Cormorants	1	Smithsonian Institution Center for Short-lived Phenomena 1970, Card no. 873 and 874.
Geese	1	Smithsonian Institution Center for Short-lived Phenomena 1972, Card no. 1372.
Gulls	1	Harrison and Buck 1967.
Gannets	1	Westphal and Rowan 1970.
Fulmars	1	Brown et al. 1973.
Coots	1	Vereshchagin 1946.

of oil pollution in the world (Table 4). Alcid populations in the Yukon, however, are small compared to those in the eastern Canadian Arctic. Only 2 colonies appear to be known in the western Arctic: a colony of fewer than 100 pairs of murres (*Uria* sp.) at Cape Parry, Amundsen Gulf (Barry 1970) and a Black Guillemot (*Cepphus grylle*) colony with some 30 pairs nesting in the mission house at the old Royal Canadian Mounted Police post at Herschel.

Of the shorebirds, the Northern Phalaropes may be most vulnerable to oil pollution along the Yukon coast as they are numerous and feed on the water. However, phalaropes may be less vulnerable to oil than sea ducks because of their relatively short migratory stops.

Of the geese, brant will be vulnerable to oil spills, although to a lesser extent than sea ducks and alcids as they stop only for short periods on Yukon coastal waters. Ouweneel (1971) reported 2000–2500 geese contaminated with oil on their staging areas, the Biesbos and Hollands Diep, in the Netherlands after a spill of 9000 metric tons of fuel oil. Species soiled with oil were Greylag Geese (*Anser anser*), White-fronted Geese, Barnacle Geese (*Branta leucopsis*) and Bean Geese (*Anser fabalis*). Only 23 geese were found dead but the total number killed is unknown due to the departure of the birds from the area. The Smithsonian Institution

(1972) reported that 1000 Pink-footed Geese (*Anser brachyrhynchus*) arriving during migration from Iceland at Invergordon, Scotland, became contaminated with oil after 30 (unspecified) tons of fuel were spilled from a leaky valve during unloading. However, none of the geese, which were roosting in a shallow bay at the time of the spill, were found dead. In the autumn of 1963, the world's population of Greater Snow Geese (*Anser caerulescens atlanticus*) was threatened with pollution as oil dumped into the St. Lawrence had drifted onto the marshes where the birds reside for 2 months. Disaster was avoided by removal and burning of oiled vegetation in the marshes before the geese arrived (Eagles 1964).

Glaucous Gulls, the fifth most numerous species observed along the Yukon coast, will not likely be much affected by oil spills, even though they scavenge most of the summer along the coastline. Gulls can fly over surface pollution and usually have little cause to land in it (Bourne 1968). Moffitt and Orr (1938) reported that gulls escaped major destruction from an oil spill on San Francisco Bay because they feed from the water surface on the wing and rest on the salt water less than diving birds.

The presence of pack ice and the scouring action of ice over the shallow continental shelf of the Yukon may increase the probability of spills resulting from offshore oil exploration, from a possible submarine pipeline connecting Herschel with the mainland, or during oil transfer operations at Pauline Cove. A spill in winter or spring could hinder clean-up operations and large quantities of oil might be trapped beneath the ice (Glaeser and Vance 1971). An oil spill on ice may be covered by falling snow which may make visual detection of its extent impossible and consequently would result in clean-up difficulties (McMinn 1972). Artificial clean-up agents are of little use in winter conditions and oil recovery techniques in the Arctic winter appear to be rapid burning and/or mechanical recovery (Vance 1971, McMinn 1972). Clean-up operations in the summer may be as bad as or worse than in the winter. The relatively low viscosity of oil in summer, may cause it to spread over ice and water. Since there is a lack of, or little, biodegradation in arctic waters (Glaeser and Vance 1971), the oil may be around for a long time and in the absence of clean-up operations could move into lagoons and bays, where it would constitute a threat to molting sea ducks.

The bays bordered by barrier reefs at river mouths along the Yukon coast constitute natural wind-protected havens for molting sea ducks. Oil companies may remove gravel from those reefs to create artificial islands for offshore drilling. Since natural transport of gravel and sediment from North Slope rivers into the Beaufort Sea is slow (Barnes and Reimnitz 1974; Naidu, in press), permanent damage may be done to reefs. A com-

bination of waves, wind, and ice may speed up the erosion of barrier reefs without gravel replenishment and consequently result in destruction of molting areas. If left alone, the reefs may also constitute natural barriers against potential oil spills. Floating boom barriers connecting the reefs south of Herschel Island and along the Malcolm and Firth rivers might keep oil spills, originating elsewhere, out of the most important molting area of Oldsquaws and Surf Scoters along the Yukon coast.

Besides the direct effects of oil, seabirds can be harmed indirectly by contamination of their food supply (primarily marine invertebrates). Marine invertebrates in polar regions grow slowly and development to sexual maturity of certain species may take years (Chia 1970). If an oil spill destroys a marine invertebrate community in the Arctic, replacement will be slow and sea ducks relying on marine invertebrates for food may be forced to leave for other localities where feeding and molting conditions are poor.

SUMMARY

A survey along the Yukon coast in August and September 1973 showed that approximately 5500 Oldsquaws and 4500 Surf Scoters use the reef-barrier-enclosed bay between Herschel Island and the mainland. No other such large sea duck concentrations were observed along the Yukon coast. Oldsquaws and Surf Scoters will be the most likely victims of potential oil spills because of their concentrations, long molting periods, reaction to spills, and nearness to expected oil exploration activities. Large numbers of brant and Northern Phalaropes, which stop during migration in coastal lagoons and river deltas, will also be vulnerable to oil pollution, although to a lesser extent than the sea ducks, because of their relatively short migratory stops.

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